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Research article

# Protective effect of curcumin on cadmium induced alteration in serum lipid profile of albino mice

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**Abstract**

Cadmium exposure can induce acute lethal health related threats in humans since it has exceptional ability to accumulate in the tissues of living organisms and cause toxicological effects. Curcumin on the other hand has a wide variety of biological activities and has protective effects against several ailments and infections. The present study was conducted to determine the cadmium induced toxicity and protective effects of curcumin on lipid profile of mice. Mice were divided into four groups. Group 1 mice were kept as control. Group 2 mice were given 1mg/kg bw of cadmium on alternate days. Group 3 mice were given 1mg/kg bw of cadmium on alternate days and 100mg/kg bw of curcumin daily. Group 4 mice were given 100mg/kg bw of curcumin daily and were kept as positive control. Autopsies were done at the intervals of 15 and 45 days. Blood was collected, serum was separated and lipid profile was estimated. There was observed a significant increase in serum cholesterol, LDL-c, VLDL-c, triglycerides and a significant decrease in HDL-c in cadmium treated groups in comparison to control at both the intervals. But in curcumin treated groups, there levels were found to attain almost normal values as found in control. Therefore, the results suggest that curcumin has ameliorating action as it exhibited the ability to resist the harmful action of cadmium.

## Introduction

Toxicity due to heavy metal is one of the major environmental problems and remains a serious health concern today. Cadmium is a natural occurring metal with atomic number 48 and atomic mass 112.41[1]. Contamination of environment by cadmium is mainly through industries and agricultural fertilizers. Cadmium is known to enter the food chain and can undergo bioaccumulation causing serious health problems. It is absorbed via three different ways: gastrointestinal tract, skin and respiratory system [2]. Cadmium is also present in useful products in the form of nickel-cadmium batteries, dyes, plastics, electrochemistry, paint pigments [3-4]. Therefore, Cd is a wide-spread environmental pollutant, characterized by its toxicity to various organs, including kidney, liver, lung, heart, testis, brain, bone and blood system [5-6]. Cadmium accumulation has been shown to affect the cell physiology and growth [7].
Cadmium stimulates the production of reactive oxygen species which leads to the oxidative damage to lipid bilayer, proteins, and antioxidant defense system in our body [8]. Thus oxidative stress damages the biological membranes of cells and tissues in body.
Cardiovascular disease remains the world's leading cause of death [9]. Therefore Serum lipid profile is measured for cardiovascular risk prediction and has now become almost a routine test. The test includes four basic parameters: total cholesterol, HDL cholesterol, LDL cholesterol and triglycerides [10]. Cadmium exposure can cause cardiovascular disease mortality [11-12] and may impair the serum lipid profile.
Medicinal plants play an important role in the management of different diseases [13]. Plant products are known to show the protective effects by scavenging free radicals and modulating antioxidant defense system. Curcumin, a yellow coloring ingredient of the spice turmeric obtained from the rhizomes of Curcuma longa Linn (Zingiberacea). Curcumin has an anti-inflammatory, antioxidant, anticarcinogenic, antiviral and anti-infective properties [14-15]. It can inhibit the generation of reactive oxygen species with its antioxidant properties and prevent the cells from oxidative damage.
Therefore, the aim of the present study was to investigate the impaired lipid levels due to cadmium toxicity and protective role of curcumin at different intervals in albino mice.

## Experimental

### Material and method

#### Animals

Albino mice weighing 20-22 grams were procured from Central Research Institute, Kasuali. They were acclimatized for 2 weeks and were given standard mice feed and *ad libitum* access to tap water. The animals were handled with human care in accordance with the guidelines of the Institutional Animal Ethical Committee under the approval number (107/99/CPCSEA/2014-32).

**Chemicals**

Cadmium Chloride ($CdCl_2$) and Curcumin were obtained from Himedia Laboratories Pvt. Ltd. MUMBAI. Cadmium was dissolved in distilled water and was administered to mice orally. An aqueous suspension of curcumin was made [16] and administered orally to mice.

**Experimental design**

Experiment was performed at two intervals i.e., 15 and 45 days.

Mice were divided into following 4 groups and 5 mice were kept in each group. **Group 1** mice were kept as control. **Group 2** mice were administered an oral dose of 1mg/kg body weight of Cd on alternate days. **Group 3** mice were given an oral dose of 1mg/kg body weight of Cd on alternate days and 100mg/kg body weight of curcumin daily. **Group 4** mice were given an oral dose of 100 mg/kg body weight of curcumin daily and were kept as positive control. Autopsies were done on 15 and 45 days post treatment.

**Biochemical studies**

After autopsy, the blood samples were collected in separate eppendrof tubes from mouse of each group under ether anesthesia. The blood samples were centrifuged (3000 rpm at 2°C for 15 minutes) and serum was collected in fresh clean tubes and was stored at -20°C and then used for biochemical analysis (lipid profile).

**Lipid profile**

Quantitative estimation of cholesterol concentration in serum was done by using commercial kit (Agappe diagnostics limited). High Density Lipoprotein (HDL) was determined by using kit (Transasia bio-mediclas limited). Triglycerides concentration was determined by using kit from Agappe diagnostics limited. Low density lipoprotein (LDL) was determined indirectly by Friedewald's formula: LDL (mg/dl) = Total cholesterol–HDL–(0.20 x triglycerides). Very low density lipoprotein (VLDL) was determined by using the formula: VLDL (mg/dl) = Triglycerides (mg/dl)/ 5.

**Statistical analysis**

The data was analyzed using Student's *t*-test through graphpad software prism 7.

**Results and discussion**

Cadmium is a toxic heavy metal and is widely distributed in the environment. It enters in the body of the organisms via inhalation or ingestion and affects their health. Ingestion may be the main route for non occupational exposure of people while inhalation acts as the major pathway for occupational exposure of people to cadmium [17-19]. In this study, animals were administered cadmium orally, which mimicked real situation of human exposure to cadmium. Investigating the levels of serum lipid profile is necessary to avoid the problems related to cardiovsascular system of body. The serum lipid content (Cholesterol, HDL, Triglycerides, LDL, VLDL) was found to be disturbed with cadmium administration. Cholesterol, triglycerides, LDL, VLDL concentration were increased and HDL concentration was decreased with cadmium administration which are discussed below. This is accordance with the results of other authors [20-21].

In this study, a significant increase in serum cholesterol concentration was observed in comparison to control mice at both the intervals (Figure 1). This gradual rise in serum cholesterol level could be due to the changes in the gene expression of some hepatic enzymes such as hydroxyl-methyl-glutaryl Co A reductase (HMG-CoA) due to cadmium [22]. HMG CoA reductase is the rate limiting enzyme in cholesterol biosynthesis. Cadmium might have stimulated the activity of this enzyme [23]. Decreased activity of cytochrome P450 enzymes could also be the reason of increased cholesterol concentration [24]. High serum cholesterol concentration may also be due to hypatic dysfunction [25, 22].

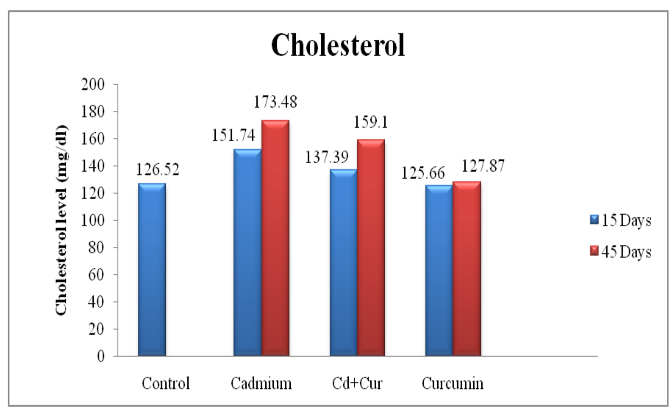


**Figure 1. Cholesterol level in control and treated groups.**

HDL protects against LDL-induced toxicity [26]. It is atheroprotective, primarily through its role in transporting cholesterol from macrophages and other cells to the liver for excretion into the bile, a process termed as reverse cholesterol transport. HDL concentration was found to be significantly decreased in comparison to control at both the intervals in present study (Figure 2). As cigarette smoke contains cadmium, Neki [27] suggested that smoking can results in fall in oestrogen level which leads to decreased HDL cholesterol. So, decreased HDL level observed in this study can also be attributed to the decreased oestrogen level in cadmium treated mice.

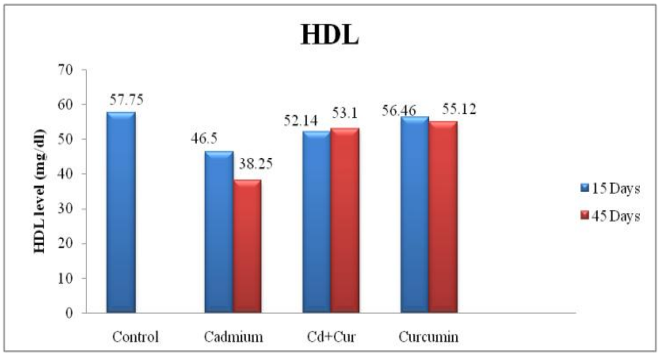


**Figure 2. HDL level in cadmium and treated groups.**

A triglyceride is an ester of glycerol and other three fatty acids. It helps in the bidirectional transference of adipose fat and blood glucose from the liver [28]. There was significant increase in serum triglycerides content in cadmium treated group at 15 and 45 days (Figure 3). High triglyceride concentration has been linked to atherosclerosis and the risk of heart disease. The rise in TG level is possibly due to hypoactivity of lipoprotein lipase in blood vessels which may explain impaired triglycerides metabolism and higher triglyceride levels [29]. The high TG content along with decreased absorption of fatty acids by adipose tissue is associated with a low level of HDL, insulin resistance and increased risk of atherosclerosis [30].

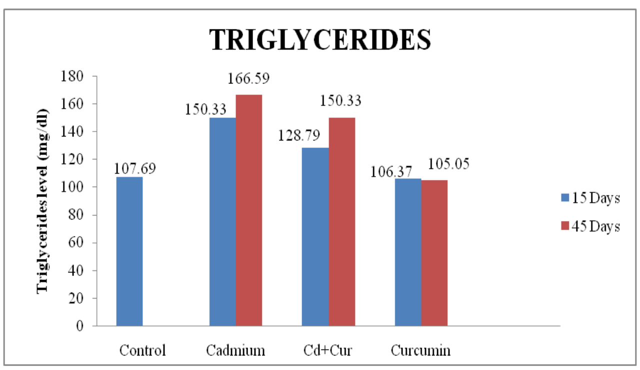


**Figure 3. Triglycerides level in control and treated groups.**

In the present study, the concentration of LDL and VLDL was significantly increased in cadmium treated group in comparison to control and curcumin group (Figure 4 and Figure 5). In rats, similar increase in both has been reported earlier by Larregle [31]. This increase could partly be due to a reduced efflux of circulatory VLDL cholesterol particles as a consequence of a decreased lipoprotein lipase (LPL) activity or loss of LDL receptor function, leading to decreased LDL catabolism and elevated LDL levels [23], LDL is known to have a major role in atherosclerosis development [32].

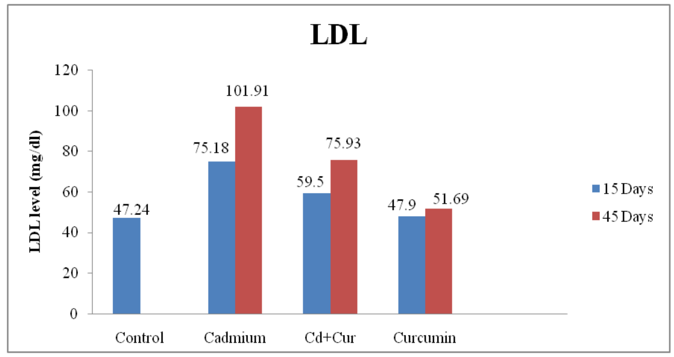


**Figure 4. LDL level in control and treated groups.**

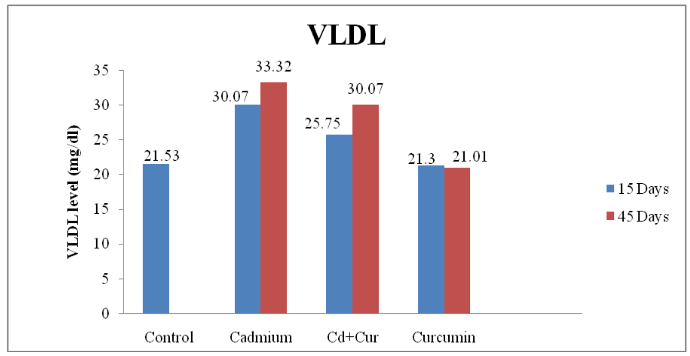


**Figure 5. VLDL level in control and treated groups.**

## Conclusion

In the present study, total cholesterol, LDL, VLDL and triglycerides values were observed to be higher in cadmium treated groups as compared to control and curcumin treated groups. But serum level of HDL was lower in cadmium treated groups as compared to control and only curcumin treated groups. Increased duration of cadmium exposure adversely affected the lipid profile. As it is well known that disturbed lipid profile plays a major role in development of atherosclerosis and also raises the risk of cardiovascular disease.

Curcumin treated groups showed almost normal levels of lipid profile, which proves the protective efficacy of curcumin against cadmium induced damage to serum lipid profile. Thus it is suggested that we should include curcumin in our daily diet to combat the heavy metals induced toxicity in our body and to keep at bay the risk of cardiovascular disease.

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